FY-2001 DOE SNF PRECLOSURE SAFETY ANALYSIS

NSNFP STRATEGY MEETING

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FY-2001 ACTIVITIES

- **Beyond Design Basis Events (BDBE) Consequence Evaluations**
- **Waste Acceptance Requirements Document (WASRD) Criteria Development**
- **Event Frequency Parametric Analyses**
- **Isotopic & Fuel Characteristics Studies**
- **Canister Design Basis Review**
- **Planning, Meetings, and Reporting**

BDBE CONSEQUENCE EVALUATION

- **Objective**
  - Use more realistic assumptions and best-estimate inputs to perform beyond design basis event (BDBE) dose calculations for breached DOE SNF canisters
- **Status**
  - Calculation (CAL-WPS-SE-000006 REV 00) approved/released
- **Spent Fuel Evaluated**
  - Non-Metal, Non-Intact Group
    - Shippingport Light Water Breeder Reactor (LWBR) Scrap
  - Other, Non-Intact Group
    - N Reactor Spent Nuclear Fuel

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BDBE CONSEQUENCE EVALUATION

- **BDBE Assumptions**
  - Drop of canister from overhead crane results in small (<10mm^2) breach in the canister
  - Canister leak path factor (LPF) = 0.1 for particulates
  - LWBR scrap has no residual respirable particulates but some generated during BDBE from the fuel and crud
  - MCO has 6 kg UO_2 particulate and 1.3 kg water after cold-vacuum drying
  - MCO has 12 kg of UH_3 and 16 kg of UO_2 at time of shipment
  - MCO has no ignition of bulk U-metal after BDBE. Release fraction assumes slow oxidation of U-metal
  - HEPA particulate filtration of 3.0E-04 except for cesium

BDBE CONSEQUENCE EVALUATION

- **Results**
  - Shippingport LWBR Scrap
    - w/o HEPA: TEDE=0.07 rem, CDE+DDE=0.6 rem
    - w/HEPA: TEDE=3E-4 rem, CDE+DDE=5E-4rem
  - N Reactor SNF (<10mm^2 breach)
    - w/o HEPA: TEDE=0.01 rem, CDE+DDE=0.1 rem
    - w/HEPA: TEDE=6E-3 rem, CDE+DDE=7E-3rem
  - N Reactor SNF (>10mm^2 breach)
    - w/o HEPA: TEDE=0.06 rem, CDE+DDE=0.9 rem
    - w/HEPA: TEDE=6E-3 rem, CDE+DDE=7E-3rem

WASRD CRITERIA DEVELOPMENT

- **Objective**
  - Provide a basis for limiting canister radionuclide releases in the event of an accidental breach
  - Provide criteria that are not radionuclide specific
  - Only waste form parameters needed to show compliance
- **Status**
  - Criteria basis calculation complete & ready for approval
  - Sample calculation included in criteria basis calculation
  - Canister Release Dose-Equivalent Source Term criteria (Rems/Canister) included in WASRD Rev 4H

WASRD CRITERIA DEVELOPMENT

- **Calculation Assumptions**
  - Canister release limits based on back-calculation from regulatory site boundary limits for Cat 2 DBEs (no safety factor)
  - DSNF 18”/24” standard, MCO, HLW, HLW/PU, & Navy canisters and combinations thereof considered
  - DBEs include handling of transportation casks, bare canisters, and unsealed disposal containers
  - Maximum number of canisters involved in DBE can fail
  - No credit for deposition, HEPA filtration, or canister leak path factor (LPF)
  - Credit for transportation cask LPF=0.1

WASRD CRITERIA DEVELOPMENT

Canister Release Dose-Equivalent Source Terms

Canister Type	**Canister Release Dose-Equivalent Source Term (rem/canister)**	
	Effective (TEDE$_{canister}$)	**Max Organ [(CDE + DDE)$_{canister}$]**
DSNF 18” dia. canister	1.15E+08	1.15E+09
DSNF 24” dia. canister	1.38E+08	1.38E+09
MCO	1.73E+08	1.73E+09
HLW	1.15E+08	1.15E+09
Pu Can-in-Canister	1.38E+08	1.38E+09
Naval Spent Fuel Canister, MPC	6.92E+08	6.92E+09

EVENT FREQUENCY PARAMETRIC ANALYSIS

- **Objective**
  - The purpose of this calculation is to evaluate an assumed range of performance allocation failure probabilities and the effect of these failure probabilities on the frequency of a radionuclide release.
- **Approach**
  - Bounding event (crane drop) is addressed in the calculation
  - Parametric analysis on design basis failure probabilities for CTS components and DSNF, HLW, and HLW/PU canisters
- **Status**
  - Calculation checked, reviewed by NSNFP and Naval Reactors (NR), and in comment resolution

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EVENT FREQUENCY PARAMETRIC ANALYSIS

- **Assumptions**
  - Components fail to meet their design basis at different failure probabilities ranging from 10^{-6} to 10^{-4}
    - CTS Crane Yoke
    - CTS Transfer Gate
    - SNF or HLW Canisters
  - Outcomes are taken from dose analyses assuming no HEPA
    - All DSNF and HLW/Pu canisters have doses resulting from a breach that exceed limits
    - Naval SNF canisters and HLW canisters have dose resulting from a breach that is within limits

EVENT FREQUENCY PARAMETRIC ANALYSIS

CASE 2: 1.0E-05 Probability of Canister Breach due to Canister, Yoke, or Gate Failure								
Canister type	**Crane Failure Rate**	**Canisters per year**	**Number of Lifts/transfer**	**Drop Frequency**	**Item Failure**	**Failure Probability**	**Release Freq. Events/year**	**Outcome**
HLW	1.40E-05	840	2	2.35E-02	Yoke	1.00E-05	2.35E-07	ML
HLW	1.40E-05	840	2	2.35E-02	Gate	1.00E-05	2.35E-07	ML
HLW	1.40E-05	840	2	2.35E-02	Canister FBDB	1.00E-05	2.35E-07	ML
HLW	1.40E-05	840	2	2.35E-02	Canister AODB	1.00E-05	2.35E-07	ML
Total							9.41E-07	ML
Pu/HLW & DSNF	1.40E-05	210	2	5.88E-03	Yoke	1.00E-05	5.88E-08	EDL
Pu/HLW & DSNF	1.40E-05	210	2	5.88E-03	Gate	1.00E-05	5.88E-08	EDL
Pu/HLW & DSNF	1.40E-05	210	2	5.88E-03	Canister FBDB	1.00E-05	5.88E-08	EDL
Pu/HLW & DSNF	1.40E-05	210	2	5.88E-03	Canister AODB	1.00E-05	5.88E-08	EDL
Total							2.35E-07	EDL
NAVY	1.40E-05	15	1	2.10E-04	Yoke	1.00E-05	2.10E-09	ML
NAVY	1.40E-05	15	1	2.10E-04	Gate	1.00E-05	2.10E-09	ML
NAVY	1.40E-05	15	1	2.10E-04	Canister FBDB	1.00E+00	2.10E-04	ML
NAVY	1.40E-05	15	1	2.10E-04	Canister AODB	1.00E+00	2.10E-04	ML
Total							4.20E-04	ML
TOTAL EDL							**2.35E-07**	EDL
TOTAL ML							**4.21E-04**	ML
TOTAL AR							**4.21E-04**	AR
FBDB = (flat bottom design basis) = The canister design basis for a flat bottom drop								
AODB (any orientation design basis) = The canister design basis for a drop in any orientation								
ML (meets limits) = The sum of all senarios that meet DBE Category 2 release limits,								
EDL (exceeds dose limits) = the sum of all scenarios that meet DBE Category 2 release limits								
AR (any release) = ML + EDL								

ISOTOPIC & FUEL CHARACTERISTICS STUDIES

- **DOE SNF Source Term Development - NSNFP**
  - YMP representation at NSNFP/EM site weekly telecon
  - Review of NSNFP template methodology uncertainties
    - Actinide concentrations do not vary linearly with burnup
    - Large uncertainties could occur if a burnup multiplier used in the source term estimate is much larger or much smaller than 1.
  - Documented basis for selection of important radionuclides
- **GOTH-SNF Analyses on metallic fuels**
  - Identify cases and review results
- **Status: Level of effort activity**

CANISTER DESIGN BASIS REVIEW

- **Objective**
  - Review DOE SNF canister design and testing
  - Develop a defensible basis for canister no-breach credit based on a suitable material strain criterion and get Nuclear Regulatory Commission (NRC) buy-in.
- **Strain Criterion Development Approach**
  - Joint effort between NSNFP and YMP using structural analysis and ASME code expertise
  - Define failure based on material strain
  - Establish design margin for defects and degradation
  - Identify precedence for strain criteria
- **Status: Level of effort activity**

INPUTS REQUIRED FROM NSNFP FOR LA

- **Inputs to Qualified LA Products**
  - MCO Drop Capability for MGR CTS Design
  - DOE SNF Canister Design Basis for Events Categorization
  - DOE SNF Source Term for License Application Chapter 7
  - Naval Reactor SNF Source Term for DBE Analyses
- **Inputs to Non-Q Products**
  - DOE SNF Source Term for BDBE Analyses
  - GOTH SNF Results for BDBE Analyses
  - DOE SNF Canister Beyond-Design-Basis Failure Modes